DOCUMENT RESUME

ED 370 561 IR 055 014

AUTHOR Mukherjee, Prachee; Edmonds, Gerald S.
TITLE Screen Design: A Review of Research.
PUB DATE 93
NOTE 9p.; In: Visual Literacy in the Digital Age: Selected Readings from the Annual Conference of the International Visual Literacy Association (25th, Rochester, New York, October 13-17, 1993); see IR 055 055.
PUB TYPE Information Analyses (070) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Computer Software Development; Courseware; *Design Preferences; Evaluation Criteria; *Instructional Design; Literature Reviews; *Screens (Displays); Visual Learning; *Visual Literacy; Visual Perception
IDENTIFIERS *Screen Format; Visual Thinking

ABSTRACT

This paper reviews the literature on screen design used for instructional purposes. The following topics are reviewed: definition of screen design; foundations of screen design; elements of screen design; functions of screen design; screen design research and problems; and criteria for evaluation. Conclusions drawn from this review are: screen design is guided by principles derived from research and common-sense heuristics; the learner is involved in the screen design process after the design is complete; and there is a need to expand the knowledge of how screen elements embedded in instructional courseware actually perform in daily instruction. (Contains 12 references.) (JLB)

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Screen Design: A Review of Research

by Prachee Mukherjee
Gerald S. Edmonds

Syracuse University
111 Waverly Ave., Suite 200
Syracuse, NY 13244

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Screen Design: A Review of Research

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Introduction

The 1980's heralded the arrival of desktop publishing, which allowed a vast number of people to publish newsletters and other documents without being cognizant of text and graphic design principles. In 1993, one does not have to look far to find computer interfaces and screens that generate 'noise' and hinder instruction and the communication of messages .

While there is research documenting the positive impact of presentations done with visuals versus those done without, specific, empirically validated (both quantitative and qualitative data) information on the design and use of visuals in instruction is not available as a coherent body of literature. The importance of visuals in instruction is only recently beginning to receive widespread attention. This paper focuses on screen design, a specific type of visual display, that is becoming increasingly important as more and more computers are used for instructional purposes. The scope of this paper is limited to a review of research on screen design used for instructional purposes. The paper begins by defining screen design and its foundations, then examine its functions, review screen design research and problems, suggest criteria for evaluation, and conclude with a critical summary of where the field is, and future directions.

Defining screen design

Defining the phenomenon under investigation can help to determine the scope and purpose of study, to identify the important relationships to be examined, and to suggest criteria by which to evaluate an example of the phenomenon. There are a number of terms in use that all refer to screen design. Some variations are screen layout design, computer based instruction (CBI) screen design, text layout, and screen layout. In a review of the literature, we found only one study that offered a definition relevant to the context of instruction: "The purposeful organization of presentation stimuli in order to influence how students process information" (Hannafin and Hooper, 1989, p. 155). Broadening and detailing this definition somewhat, screen design is defined as the coordination of textual and graphic elements to present sequenced content, in order to facilitate learning.

This definition, in directly linking screen design with the desired effect on

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learners, provides a functional approach to screen design. It allows one to focus on whether the screen design under consideration is actually providing conditions of learning. More importantly, it establishes the relationship of screen design with *learning* and learners, setting apart the field of screen design in instruction from screen design in information studies. In information studies or related fields of investigation, screen design is concerned with the 'user' and issues of usability, as opposed to the learner and learning. The shift in the nature of the situation is from searching to learning.

Foundations of Screen Design

Hannafin and Hooper (1989) identify three foundations of screen design: (1) psychological, (2) instructional and (3) technological. The psychological foundations of screen design form the empirical basis for screen design, focusing on issues related to perception, attitudes, and information processing abilities of learners. The instructional foundations are issues related to instructional, rather than cognitive/learning problems. The learner, content and instructional setting are all analyzed under instructional foundations. Technological foundations provide the possibilities and limitations of instructional technologies. (Hannafin and Hooper, 1989)

In addition to the foundations outlined above, a fourth one, aesthetic foundations, derived from art and design, also inform screen design principles. Although not always explicitly named as such, screen design principles influenced by aesthetic considerations, take into account how various elements should be combined for visually pleasing effects.

The design of computer screens has traditionally fallen to the individuals or teams programming and developing instructional software, who typically do not have a background in either graphic design or visual literacy theory. Galitz (1985) notes that technical features received greater attention than the human factors involved in processing the displayed information (p. 2). As a result screen design has "...tended to be unsystematic and inconsistent, and has failed to adequately reflect human perceptual and processing capabilities" (Galitz, 1985, p. 2). Early screen designers applied graphic design elements used in the creation of paper based documents, disregarding important differences between computer screens and pages (Table 1).

Screens	Page
Information written anywhere at any time	Page is frozen
Dynamic nature of text • animation	Information static • no animation • info cannot be rewritten
Time dimension • slowly or quickly	Information is only presented once
Information tied to display	Information tied to paper but can be taken away from site

Table 1. Screen vs Paper

Much of the screen design literature presents strategies for screen design, without linking the strategies to research evidence or experience. General heuristics on all aspects of screen design abound, but these too, are not grounded in research or instructional design principles. Misanchuk (cited in Grabinger, 1993) notes:

> While aesthetic guidelines exist to help designers create attractive displays; ...aside from Hartley's (1978) work, there are few, if any, empirically based guidelines to help instructional designers combine text elements in ways that facilitate learning (p. 35).

The use of screen design to provide a bridge between information and learners adds a layer of complexity to the design of instructional screens:

> CAI designers need more than aesthetic guidelines. They need guidelines that are focused on learning, guidelines that will help instructional designers create displays that facilitate the process of reading and learning – the acquisition, organization, and processing of information by learners (Grabinger, 1993, p. 36).

The focus on compound elements used to enhance comprehension and learning dictate that a set of screen design guidelines should "...go beyond legibility standards and indicate what designers should do to enhance the process of organization and integration" (Grabinger, 1993, p. 36). Single elements and the numerous combination of screen and software elements make conducting research on screen design daunting. Single elements like bolding a word, by itself, most likely do not impact learning (Grabinger, 1993). Grabinger (1993) comments that the combination of single variables into complex elements used to organize a display, chunk information, or structure information may affect how a learner perceives, comprehends, integrates and processes information.

Elements of Screen Design

There are a number of elements which are available in comprising an effective screen. Heines (1984) divides the screen into a number of functional areas, for example navigation, which allows for the consistent placement of certain combinations of elements (such as forward and backward buttons) from screen to screen. Examples of functional areas (Figure 1) include, but are not limited to, orientation, directions, feedback, student options, text areas and video areas.

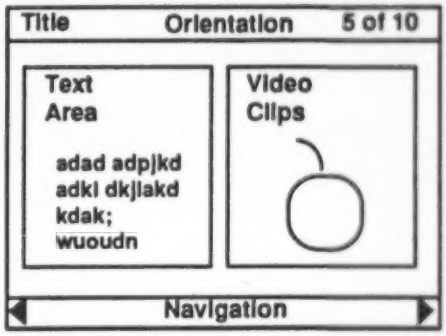

Figure 1. Computer Screen Divided into Functional Areas

Screens are also comprised of numerous graphical icons and symbols which guide the user, but at the same time, remain unobtrusive (Heines, 1984). Graphical symbols include buttons which perform some action when they are activated. The use of icons representing commands/actions should be derived and based on images that make sense to the learner and not to the screen designer alone (Edmonds, 1993). Often, certain icons are included, whose functions are not intuitively apparent to the learner.

Screens also display text which include a number of features including message clarity and message readability. The designer can manipulate type style, line length, justification, break points, and character attributes (such as bolding).

Functions of screen design

Galitz (1985) notes that research on screen design preferences reveal that users want

- an orderly, clean, clutter-free appearance;
- an obvious indication of what is being shown and what should be done with it;
- expected information where it should be;
- a clear indication of what relates to what (headings, field

captions, data, instructions, options and so forth);

- plain, simple English; and
- a simple way of finding what is in the system and how to get it out (p. 38).

Good screen designs are expected to fulfill a number of requirements (Heines, 1984; Hannafin & Hooper, 1989; Grabinger, 1993), as described below:

- Focus learners' attention: The screen should be designed so as to focus learners' attention on relevant lesson content.
- Develop and maintain interest: It is the function of a good screen to motivate learners to expend the necessary effort to undertake the learning task. Emphasizing two-way interaction, Heines (1984) suggests that "students should be drawn into the subject matter" (p. 133).
- Promote deep processing: In order that learning and encoding occur, effective screen design must allow learners to integrate new content into their schematas. Successful screen designs facilitate appropriate interactive processes (such as reading and perception) (Grabinger, 1993, p. 36).
- Promote engagement between learners and lesson content: Engagement is described in terms of quality and quantity (frequency) of interaction between learners and content. Engagement results from a balance between "easily accessible learner-based 'tools,' and designer-based techniques" (Hannafin and Hooper, 1989, p. 159).
- Help learners find and organize information, and facilitate lesson navigation: To eliminate or minimize learner frustration, effective screen design aims at establishing and consistently following certain protocols to orient learners, such as using functional areas (Edmonds, 1993; Grabinger, 1993; Heines, 1984). This prevents learners from getting 'lost' or stuck in a loop, helps them to navigate successfully through the lesson, and also, to fully devote attention to content processing (Hannafin and Peck, 1988; Heines, 1984; Kerr, 1983).

A well designed screen: (1) reflects the needs and idiosyncrasies of its users, (2) is developed within the physical constraints imposed by the terminal, (3) effectively utilizes the capabilities of its software (Galitz, 1985, p.37) and (4) achieves the instructional objectives of the program for which it is designed.

Those who focus on screen design functions from a non-instructional design perspective may sometimes pay attention to learner needs and characteristics such as memory and perception, but only at a superficial level. For example, Galitz (1985) points out that screen designers should keep individual differences in mind, but fails to explain how that would specifically affect design strategies.

Screen design research and problems

A number of factors make screen design research problematic:

- An innumerable possible combination of elements of screen design exists. Additionally, even when it is known which elements have been combined, the overall effect of the combination is not equal to the sum of the effects of each individual element.

Grabinger (1989, p. 179) aptly names this overall effect the visual 'gestalt.'

- Many screen design elements are physically invisible, as are learning processes. For the latter, one must fall back on inferential speculations on the nature of learning processes employed. Research methods tend to be comprised of student self-reports or post-lesson interviews with students (to identify macro-processes employed, or effort expended by learners).

- Changes in screen design, as well as effects of screen design, can be very small or negligible. Although pre-post research designs have been employed (to train students in specific strategies and then testing them later to measure the impact), it remains difficult to measure such small effects with any success.

As noted earlier, there is a lack of research on screen design and its effects on learning. Even studies that claim to provide guidelines based on research findings such as Aspillaga's (1991), make screen design recommendations based on research done with a non-electronic medium. Galitz (1985) mentions in the introduction to his book on screen design that his guidelines are based on experience, research findings, informal studies, and "known" psychological principles; however he does not care to disclose which guidelines are derived from which of these many sources.

Broadly speaking, research in this area either consisted of comparison studies (with some other non-electronic teaching method), or evaluating whether or not lesson objectives were achieved (Hartley, 1978). A third kind of research focuses on studying the effects of manipulation of screen design elements on learning. In experimental research, there have been two approaches: (1) those that investigated the impact of single elements of screen design on learning, and (2) those that investigated the impact of multiple elements (or combination of elements) on learning (Grabinger, 1989).

In the experiments conducted by Grabinger (1993), the screens are separated from the context and content in which learners will encounter them in real life. The problem with such studies is discussed by Neuman (1991):

> Reality ... is indivisible as well as multiple. Residing wholly in an individual's mind, reality can not be fragmented into variables to be studied in isolation. Separating any part from the whole invariably alters both the part and the whole; studying only discrete parts therefore distorts the reality we seek to understand. (p. 41)

In the case of screen design, the 'whole' is comprised of the interaction between the screen, content, media, learner, and context (Figure 2).

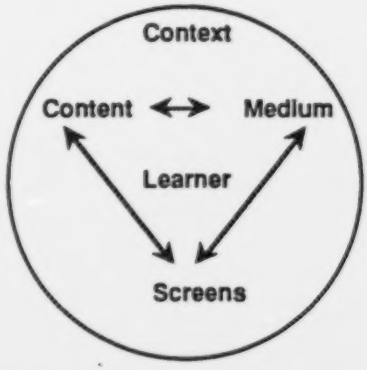

Figure 2 The Learner/ Computer Interface

Criteria for evaluation

Given the research and scope of screen design, are there any derivable criteria on evaluating effective screen

designs? The criteria suggested by the functions of screen design relate to:

- orienting learners
- encouraging deep processing
- focusing attention
- engaging learners

All these criteria can be considered along the dimensions of quantity (or frequency) and/or quality of interaction.

Hartley (1978) suggests that electronic text can be evaluated in a number of ways, for content, typography, and teaching effectiveness. For assessing teaching effectiveness, he advocates looking closely at readability, and suggests a number of ways for doing so.

Discussion

At present, screen design seems to be guided by principles derived both from research and common-sense heuristics. The major difference between the two is that common-sense rules all tend to cluster around issues of learner orientation and information presentation. This is done at the cost of neglecting instructional aspects, such as ensuring that certain cognitive processes are employed. Using Hannafin and Hooper's ROPES framework, which is comprised of Retrieval, Orientation, Presentation, Encoding, and Sequencing (1989) respectively, most of the intuitive rules for screen design that are not grounded in research tend to overlook Encoding and Sequencing. Additionally, many screen design guidelines are generalizations from research done on non-electronic medium such as print. The conclusions about screen design tend to remain stuck at the word-level, rather than examining macro issues (Isaacs, 1987).

However, both these approaches to screen design tend to share one feature and that is the placement of the learner in the process of screen design. In both instances the learner encounters the screen, after the design is complete, to provide feedback on how well a design element or combination of elements, already constructed, works. The learner's input is sought *after* the fact; after the screen has already been designed. This needs to change in view of other changes where media and instructional technology have become increasingly interactive. The emphasis should shift from screen design, a passive concept, to human interface, a more dynamic ongoing process, better reflecting the interactive technologies of today.

There is a need to deepen and expand our knowledge of the manner in which screen elements embedded in instructional courseware actually perform in daily instruction (Neuman, 1991, p. 39-40). There is a critical need to understand the particulars and nuances of the relationship of screen design elements, context, and content, to learning and knowledge construction by learners.

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